523.5

SYSTEMATIC OBSERVATION OF METEORS.

By Prof. S. A. Mitchell,

Leander McCormick Observatory, University of Virginia.

[Extracted in part from the Scientific American, v. 113, No. 2, July 10, 1915, p. 48.]

* * * While the connection between meteors and comets is of the greatest importance, still meteor observations are of great value to the meteorologist as they tell him the height of the atmosphere, the drift of the upper atmosphere, etc. Meteors in a shower move in parallel paths. These objects, which are comparatively near to the observer, are projected by the eye backward to the celestial sphere, with the result that by perspective the meteors all appear to radiate from a point—or rather small area—in the sky. Those meteors nearest the radiant have usually the shortest paths, those farthest away the longest. The meteor * * * takes its name from the constellation in which the radiant is found. The accurate position of the radiant is specially desirable, and this may be found by anyone who exercises a little care and a little patience. The general plan for observing is to have a map before one, specially prepared for the part of the sky which the observer is watching, and put down on this map as accurately as possible the meteors as they are seen. If the meteor paths when projected backward are to intersect in the radiant, the positions of the individual meteors must be plotted with accuracy. This, however, with a little experience can easily be attained.

Prof. Charles P. Olivier, of the Leander McCormick Observatory of the University of Virginia, * * * has given the benefit of his experience in some printed rules, which if followed by a beginner, will make him a valued meteor observer. The National Academy of Sciences has awarded to the Leander McCormick Observatory a small grant for the purpose of encouraging meteor researches. Fortunately a series of valuable maps of the sky has just been published by Dr. Reynold K. Young, of the Dominion Observatory. To all those who will engage in systematic observations of meteors and who will write to the Leander McCormick Observatory, University of Virginia, a series of maps and a set of rules for observation will be sent free of charge. The directions for observing meteors as given by Prof. Olivier are as follows: Maps are prepared of the region of the sky that is to be specially observed on a given night. On a separate *second* sheet, a number of columns are ruled and headed as follows:

Observer: *C. P. Olivier.*
Place: *A. S. C., Decatur, Ga., U. S. A.*
Date: *1911, Oct. 19.*
Began: *10h 31m.*
Ended: *14h 25m.*
Condition of sky: *Clear 75 per cent of time; clouds and haze during 25 per cent.*

Time. (1)	No. (2)	Class. (3)	Color. (4)	Magn. (5)	Distance. (6)	Duration. (7)	Duration of train. (8)	Beginning. (9) α	Beginning. (9) δ	Ending. (9) α	Ending. (9) δ	Accuracy. (10)	Serial No. (11)
H. m. s.					°	*Sec.*	*Sec.*	°	°	°	°		
10 30 10	*1*	*S*	......	*5*	*5*	*0.4*	*0.4*	....	....	....	....	*W*	*11–157*
40 30	*2*	*S*	......	*5*	*12*	*0.4*	*0.4*	....	....	....	....	*N*	*8*
42 30	*3*	*S*	......	*4*	*10*	*0.4*	*0.5*	....	....	....	....	*N*	*11–160*
48 40	*4*	*S*	*G*	*1*	*8*	*0.6*	*1.5*	....	....	....	....	*F*	*1*
52 30	*5*	*O*	......	*6*	*3*	*0.6*	*0.6*	....	....	....	....	*W*	*2*
11 4 40	*6*	*S*	*O*	*3*	*9*	*0.8*	*0.5*	....	....	....	....	*W*	*11–163*

(1) Usually to get time to within 10 sec. is quite accurate enough.
(2) The number of the meteor on the map used this night.
(3) *O*=Orionid. *S*=any other.
(4) *G*=green. *O*=orange, etc.
(5) Use ONLY number. Avoid bright, faint, etc.
(6) Estimated at time as check. Not measured from map.
(7 and 8) Estimated by "dead" reckoning. Most beginners estimate time too long.
(9) These four coordinates to be measured off and filled in later if necessary.
(10) *W*=well observed.. *F*=fairly observed. *N*=not well observed.
(11) Filled in next day.

[Please use this form for all your future observations. Notes about any meteor may be written on the back, i. e., anything peculiar, as a curved path, etc.]

DIRECTIONS FOR OBSERVING METEORS.[1]

By Charles P. Olivier.

[Leander McCormick Observatory.]

For the information of new members who are just starting in this work, the following rules and suggestions are given:

(1) Choose a place of observation with as free a horizon as possible, far from arc or other bright lights, away from city smoke, and free from fog.

(2) Use a lantern which is unaffected by wind, while a table and chair generally save time and promote comfort.

(3) Provide a star atlas, the recording maps, the recording blanks, a long rod or rule, a watch, several sharp pencils, weights to hold down papers if windy.

(4) Observe only on clear nights—that is, when stars of the 5th magnitude at least are visible. Haze and moonlight by cutting out all faint meteors, make observing inadvisable.

(5) Except on rare occasions observations of less than one hour are not recommended. Two- to 4-hour periods are best. They should be continuous.

(6) Use record blanks furnished, following instructions given on specimen copy.

(7) The maps may either be traced from some standard atlas or bought. In the first case the atlas used must be recorded. The meteor's path is shown in length and direction by an arrow as $\xrightarrow{37}$, with the proper number. By means of a mimeograph several dozen copies may be made after the first has been traced, using the prepared ink for the first. This will save time immensely. A few hours of work would thus give more maps than could be used for a year or two.

(8) As to tracing the meteor's path upon the map correctly, experience only will show how each separate case must be handled. However, I suggest the following plan:

The whole problem is merely to determine accurately the end points of the path. Joining these points gives the correct trace on the map. Hence, if a meteor begins and ends exactly at two stars, the trace gives no trouble. This is not usually the case. But either end may often fall halfway, or some other easy fraction of the distance, between two stars. Then one can measure off this proportion on the map and plot as before. But a better way is this, especially for those who have to use maps traced from an atlas whose projection is bad for the region needed. It is never difficult to find some *one* point in the meteor's path. Then glancing backward along the rod, held parallel to the path in the sky, one readily picks up some star at a distance from which the meteor seemed to come. These two points determine its direction. Using the first star as reference point, one can estimate how many degrees of the path lay behind and how many before the said star, and so an excellent plot is obtained. This method, used with care, largely or entirely eliminates the projection errors from the radiant deduced, if the meteor begins within from 20° to 40° of it. This method is recommended for observers unable to obtain specially prepared meteor maps on the central projection. We are now able, however, to furnish such maps at very low cost to our members.

Members are strongly urged to read the chapters on meteors in such standard texts as Young, Moulton, Todd, and others. The article on meteors in the Encyclopædia Britannica will be found excellent. Many helpful articles often appear in Popular Astronomy and some of the foreign astronomical journals.

In closing it may be well to recall to the members the conditions of membership, which are only two: (1) That

[1] Being Bulletin No. 3 of American Meteor Society.

each member shall observe meteors when possible. (2) That reports are to be sent in at first of each month. These reports consist of the maps and blanks actually used when observing, with additional notes if necessary.

In case an observer may feel unable to undertake the full program of work as outlined, he can still do useful work by counting the number of meteors that fall per hour with careful notes as to the condition of the sky. Anyone who observes between July 20 and August 30 is sure to catch a large number of meteors. The number of meteors seen per hour increases from sunset to dawn, the greatest number generally being seen just before sunrise. The present time of year is a most auspicious one for the beginner in meteor observing. The weather is warm, so that observations can be made in comfort. During the latter half of July and throughout August a meteor may be seen by anyone who has patience enough to watch for 5 to 10 minutes, while two or three or even half a dozen may be seen in this time. The beginner should be cautioned against trying to observe when the sky is not perfectly clear, or when the moon is bright, for then only the very brightest meteors can possibly be seen. Most astronomical work is valuable only when followed up regularly and systematically, but each night's work on meteors is separate and valuable by itself. Each observer will get full credit for all of the work which he sends in to the Leander McCormick Observatory, which by the grant of the National Academy has become the central bureau for meteor observations in America. Here is a splended chance for amateurs to do real astronomical work. [And one may add real meteorological work also.—*Editor*.]

551.508.23

INTERNAL REFLECTION AS A SOURCE OF ERROR IN THE CALLENDAR BOLOMETRIC SUNSHINE RECEIVER.

By ERIC R. MILLER, Local Forecaster.

[Dated: Weather Bureau, Madison, Wis., June 7, 1915.]

The Callendar bolometric sunshine receiver has already been described in the Monthly Weather Review by Kimball,[1] and elsewhere by various investigators. It may be regarded as being, essentially, either a bolometer with both strips exposed, one blackened and the other bright, or a platinum resistance thermometer of the 4-lead compensated type having the thermometer coil blackened and the compensating leads including a bright coil of the same electrical dimensions as the thermometer coil, so that the only difference between the two coils is the blackening. Each coil or strip consists of fine platinum wire of about 12 ohms resistance, wound in two grids in series. The two pairs of grids are arranged checkerboard-wise, as shown in figure 1, upon a mica plate. In receiver No. 9864, the mica plate measures 6.0×6.2 cm, and the grids cover an area about 5.8×5.8 cm. The blackening consists of a coat of shiny enamel painted over and imbedding the "black" grids. The object of the instrument is to continuously register the vertical component of radiation from sun and sky. Hence, the grids are permanently fixed in a horizontal position.

In order to avoid the effects of wind, convection, rain, etc., the grids are sealed into an exhausted, ovoid bulb, part of which forms a hemispherical cover of about 9.1 cm. external diameter. A vertical section of the instrument is shown in figure 2.

It is obvious that reflection, refraction, absorption, and radiation by the glass cover, and by the metal cylinder in which the bulb is mounted, must modify the simple sine law of variation of intensity of the radiation received upon the plate. Of these errors that due to internal reflection alone will be considered here.

It is convenient to consider the bulb enclosing the receiving grids as made up of a hemisperical cover (*a* fig. 2) above the grids, a spherical zone (*b* fig. 2) immediately below the grids, next a conical zone (*c* fig. 2), and finally a spherical segment (*d* fig. 2).

The internal reflection of radiation by the hemispherical cover, *a*, takes the well-known form of the "caustic by reflection."[2] This is an exceedingly important source of error in the Callendar sunshine receiver. The entire beam (*A*, *B*, *C*, fig. 3) projected upon the interior surface of the hemisphere from M to N (fig. 3), less what is transmitted, is concentrated by reflection upon the base of the hemisphere between *A′* and *B′*. The intensity of the reflected light, and the distance that it extends into the

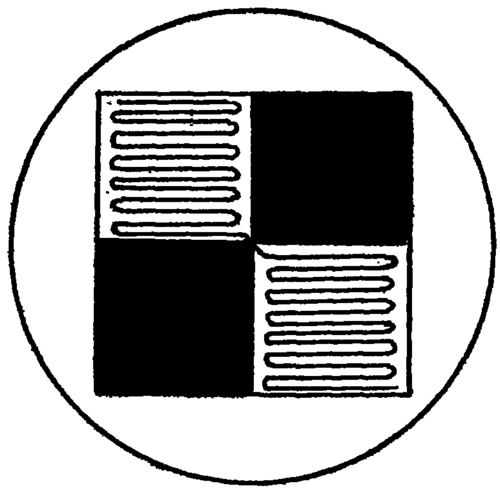

FIG. 1.—Plan of Callendar bolometric sunshine receiver. (Section through the receiving grids.)

hemisphere vary inversely with the elevation of the source of radiation above, or depression below, the plane of the base. According to the geometrical theory of the caustic, for plane waves incident parallel to the base, light reflected in this way extends into the hemisphere a distance equal to half of the radius. Inasmuch as the sides of the grids in the Callendar sunshine receiver extend 0.64 of the radius, and the corners of the grids 0.95 of the radius from the center, it is obvious that the caustic must fall upon the grids. Inspection of the instrument shows this to be the case.

In order to illustrate the changes of form and relative intensity compared with the illumination on a horizontal surface outside the hemisphere, for different elevations of the source above the plane of the base, a series of exposures of photographic plates has been made under a blown glass hemisphere, and are reproduced here in

[1] Kimball, H. H. Total radiation received on a horizontal surface from the sun and sky. Monthly Weather Review, August, 1914, 42: 474-487. (Gives bibliographic references.)

[2] Watson, W. Caustics formed by reflection in "Textbook of Physics," London, 1902 pp. 470-472.
Wood, R. W. Reflection of plane waves from concave spherical mirrors, in "Physical Optics," New York, 1911, pp. 54-63.